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SLOPE SINKING THROUGH WATER-BEARING STRATA AT MINE 3, BELL & ZOLLER COAL AND MINING CO., WILLIAMSON COUNTY, ILL.

BY

JOSEPH J. SHIELDS AND LOUIS A. TURNBULL

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SLOPE SINKING THROUGH WATER-BEARING STRATA AT MINE 3, BELL & ZOLLER COAL & MINING CO., WILLIAMSON COUNTY, ILL.[1]

By Joseph J. Shields[2] and Louis A. Turnbull[3]

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INTRODUCTION

The Bell & Zoller Coal & Mining Co. recently completed construction of two slopes at Mine 3 near Zeigler, Ill. The slopes are in the Big Muddy River Valley, and construction was particularly difficult because the strata

1/ Work on manuscript completed October 21, 1948. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7509."

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from the surface to a depth of 70 feet comprise water saturated sandy clay and sand. Many mining companies have similar shaft- and slope-sinking problems, and because these slopes were satisfactorily completed and now are in use the methods followed during construction are described in this information circular. It is believed that other companies with similar problems will benefit by adopting the methods followed at Mine 3.

ACKNOWLEDGMENTS

This report was compiled from information furnished by the officials of the Bell & Zoller Coal & Mining Co. and observations in the field by Bureau of Mines engineers. Publication of the report has been approved by the company, and the courtesy and cooperation of its officials are appreciated.

MINE SITE

The mine openings are about 5 miles west of Zeigler, Ill. Two slopes, one 18° dip and the other 30° dip, were sunk, by contract, from the surface to the No. 6 coal bed. The 18° slope will be the main haulageway and intake airway. The 30° slope will be used for the return airway in the ventilation system and for men and supplies.

The upper part of the overburden in this area is about 70 feet thick and comprises sandy clay and sand saturated with water. The remainder of the overburden is about 74 feet thick and comprises sandstone, limestone, and shale. The log of a hole drilled in the area follows:

Depth From- Ft.	Depth From- In.	Depth To- Ft.	Depth To- In.		Thickness Ft.	Thickness In.	
0	0	69	0	Sandy clay and sand	69	0	
69	0	102	0	Sandstone	33	0	
102	0	103	6	Sandstone conglomerate	1	6	
103	6	111	2	Shale (soft)	7	8	
111	2	114	2	Dark limestone	3	0	
114	2	118	8	Black shale	4	6	
118	8	144	2	Gray shale	25	6	
144	2	152	6	COAL	8	4	No. 6 Bed
152	6	154	0	Fire clay	1	6	
154	0	157	0	White limestone	3	0	
157	0	176	2	Shale	19	2	
176	2	190	11	Sandstone	14	9	
190	11	196	0	Shale	5	1	
196	0	205	6	Sandstone	9	6	
205	6	210	0	Black shale	4	6	
210	0	213	3	Gray shale	3	3	
213	3	217	3	COAL	4	0	No. 5 Bed
217	3	218	0	Clay	0	9	

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Figure 1. - Slope lining removed after the sides of the slope caved.

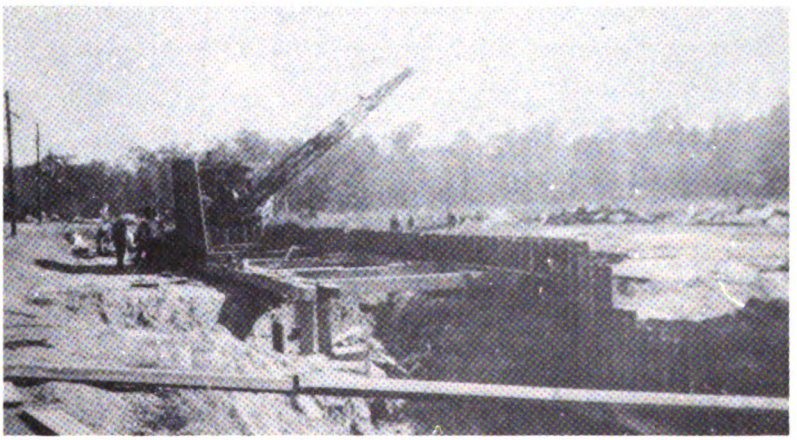

Figure 2. - Interlocking piling at the air slope.

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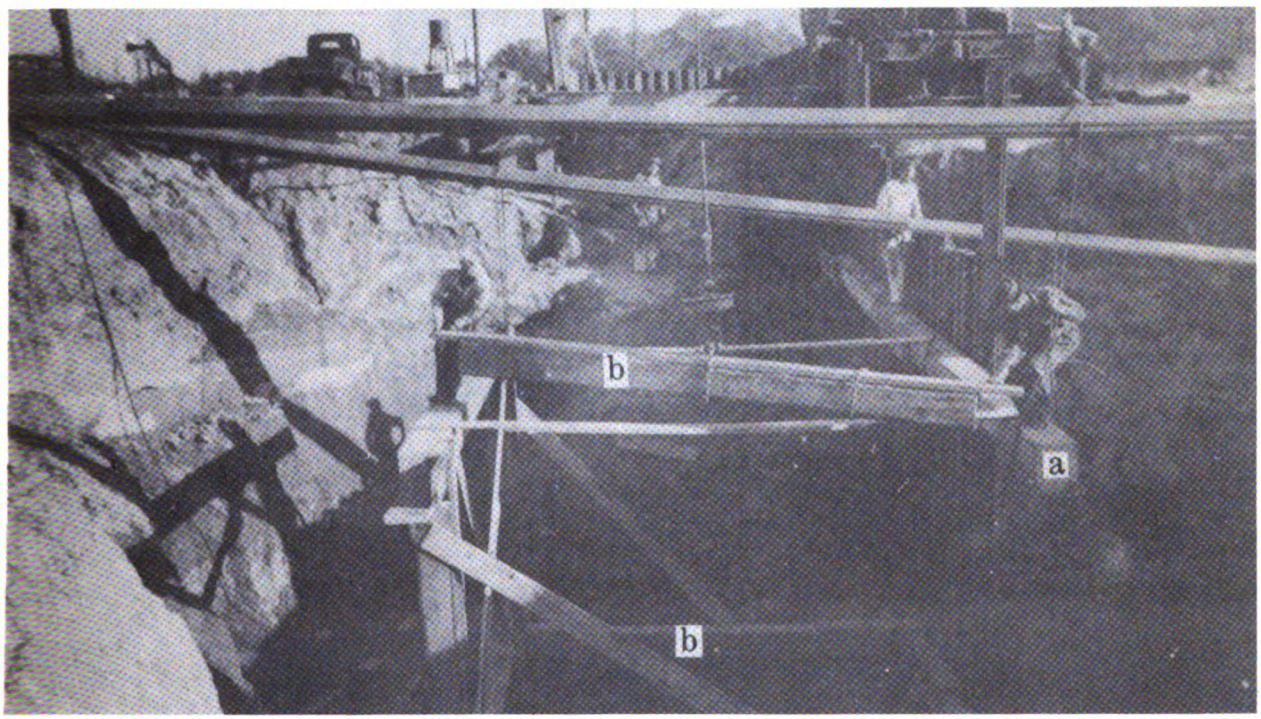

Figure 3. - Timber support for coffer-dam; a, ring timber; b, bunton.

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Figure 4. - Liner plates and assembled 18-inch sections.

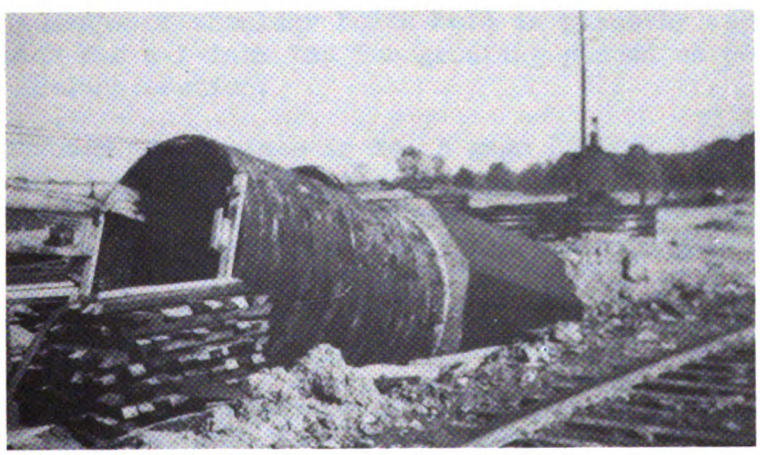

Figure 5. - Reinforced concrete around steel lining near portal of main slope.

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METHOD OF CONSTRUCTION

The original plan for development was to sink the slopes full size and place a section of corrugated steel lining for each 18 inches advanced. This plan was abandoned as impracticable when saturated, unconsolidated, sandy clay was found in the excavations. Open-cut excavations then were made for each slope, with the sides on a one-to-one slope and the bottom on grade. The steel lining was placed on grade as excavation of the slopes advanced. The work progressed only a short distance, when the unprotected, saturated, sandy clay sides of the cuts caved, and the lining had to be removed and the slopes re-excavated. (See fig. 1.)

It was then decided to excavate an open cut to the rock. The minimum width of the cut was 17 feet, and the sides were supported with an open-end cofferdam constructed with vertical, interlocking, steel piling. (See fig. 2.) The steel piling was driven below the grade line of the slopes, and then the material within the cofferdam was excavated to the grade.

As the excavations progressed, 12- by 12-inch ring timbers were placed to support the sides of the cofferdam against lateral pressure. Ring timbers were placed on decreasing centers as the depth of the excavations increased, ranging from 11 ft. 9 in. near the top to 6 ft. 0 in. near the bottom of the cut. Twelve- by twelve-inch buntons 14 feet long, spaced on 8-foot centers, were placed horizontally between the ring timbers for lateral support. (See fig. 3.)

Steel Lining

The lining is corrugated, galvanized steel heavily coated with asphalt for protection from moisture and acid waters. It is 9 feet in diameter, and each section is made of seven liner plates securely bolted together to make a circular section 18 inches wide. (See fig. 4.) These sections of lining are bolted together as the slope excavation proceeds. Assembling is done from the inside by means of shoulder bolts held in place by spring-steel clips. Each section has a 1-inch tap for grouting placed on 90° or alternate quarters in each 18-inch section.

The lining through the surface is No. 3 gage (0.2391 inch thick) and through the rock No. 7 gage (0.1793 inch thick). In the open cut at both slopes, each 9-foot by 18-inch section was assembled on the surface and then installed. When the liner entered the rock, the liner plates were assembled in place.

Method of Pouring Concrete

The lining through the surface to the top of the rock in the open cut was encased in an octagonal wood form and concreted. This concrete lining then was covered with earth. (See fig. 5.) The concrete is a 1-2-4 mix 10 inches thick, reinforced with steel rods. The lining to the rock, when completed, was covered with the excavated material and graded to the natural surface with a clamshell and bulldozer. The lining through the rock to the coal bed was poured through an 8-inch cast-iron pipe line that extended from

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the surface to the intersection of the slopes with the top of the rock. This pipe line extended through a hole in the lining and was supported along the inside of the lining by chain hangers. The pipe line was extended as the slopes advanced. Holes were punched in the top of the lining at intervals ranging from 30 to 40 feet, and the 8-inch pipe line was extended through the lining. (See fig. 6.) Concrete was forced under 30 pounds air pressure into the void between the circular steel lining and the top, bottom, and sides of the excavated slope. Air pressure was supplied by a 1-inch wrought-iron line laid down the slope from the surface and tapped into the 8-inch line near the point of discharge. Usually, a section 30 to 40 feet in length and averaging 18 inches in width around the lining was poured at one time. Grouting under pressure through separate 1-inch taps in the lining was employed to fill the voids and honeycombs in the concrete around the lining to prevent water leakage.

Compressed air for drilling the rock in the slopes and for the 1-inch pressure lines was furnished by three truck-mounted, gasoline-powered compressors on the surface - two operating and one in reserve. Each compressor had a rated capacity of 500 cubic feet per minute.

MAIN SLOPE

The main slope, dip 18 degrees, is 642 feet long from the surface to the storage bin. The storage bin, excavated in the rock below the No. 6 coal bed, has a capacity of 300 tons. A 36-inch conveyor belt 735 feet long will be installed to transport the coal from the storage bin to railroad cars on the surface. (See fig. 7.) The coal will be transported to the company's preparation plant at the No. 2 mine near Zeigler. The 36-inch belt conveyor has a rated capacity of 500 tons per hour at a speed of 425 feet per minute.

AIR AND MATERIAL SLOPE

The air and material slope, dip 30 degrees, is 283 feet long from the surface to the No. 6 coal bed. (See fig. 7.) A 150-horsepower electric hoist on the surface and a 3-foot narrow-gage track in the slope have been installed to lower and hoist men and materials. A 6-foot propeller-type fan, operating exhausting, is on the surface at the man and material slope. Two airlock doors that open overhead when man and material trips enter and leave the mine are installed on the slope. The doors will be operated hydraulically by the hoisting engineer as the man and supply trips enter and leave the mine.

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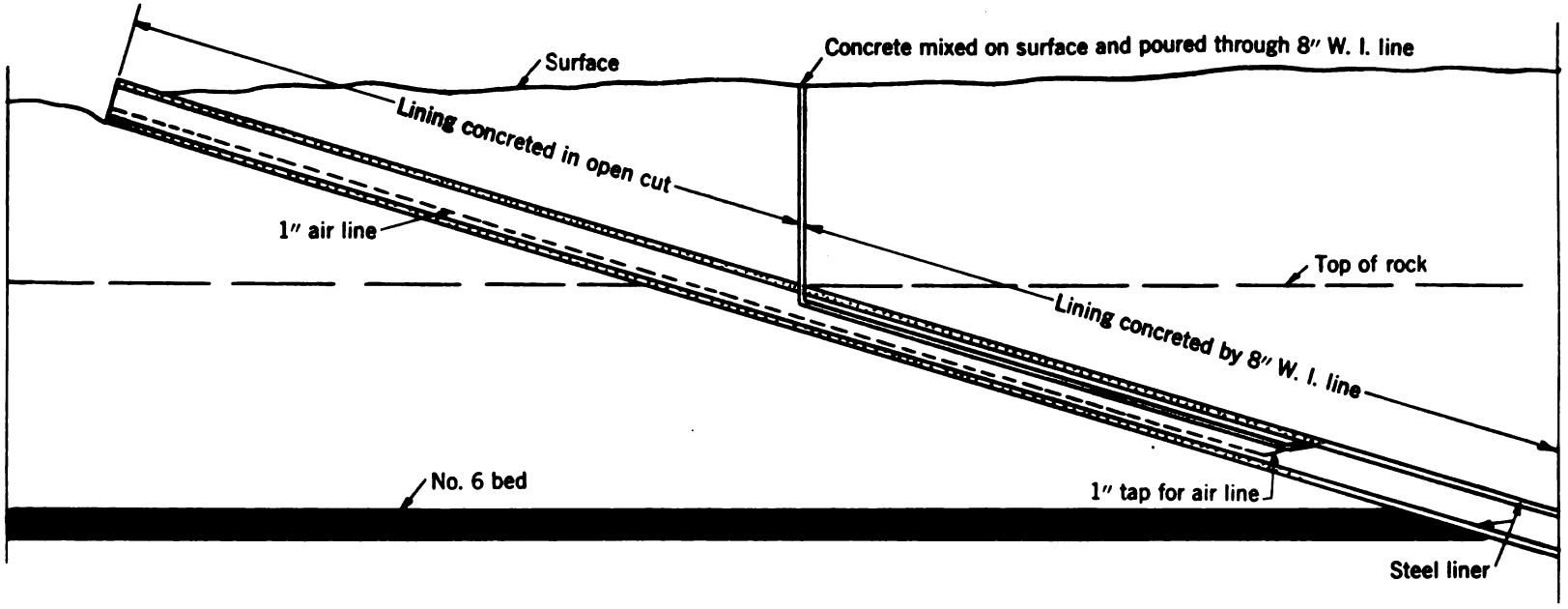
Surface
Concrete mixed on surface and poured through 8″ W. I. line
Lining concreted in open cut
1″ air line
Top of rock
Lining concreted by 8″ W. I. line
No. 6 bed
1″ tap for air line
Steel liner

Figure 6. - Method of placing concrete.

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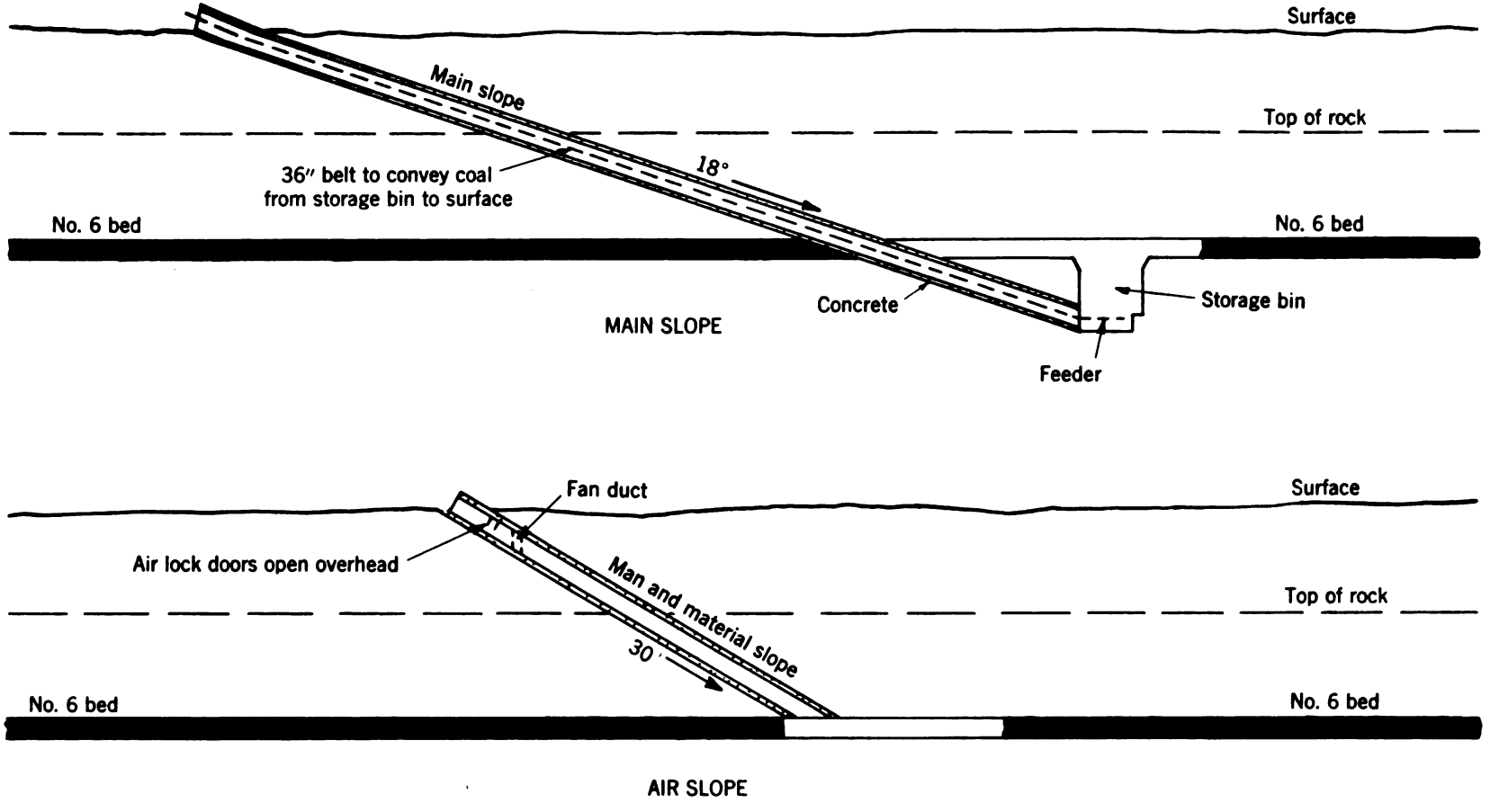

Figure 7. - Diagrammatic section of main and air slopes.

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WORKING FORCE EMPLOYED DURING SINKING OF BOTH SLOPES

First shift

1	Superintendent
1	Assistant superintendent
1	Timekeeper
12	Sinkers
2	Top cagers
1	Fireman
2	Hoisting engineers
1	Pumpman
1	Mechanic
2	Top laborers
24	

Second shift

1	Foreman
1	Timekeeper
12	Sinkers
2	Top cagers
2	Hoisting engineers
1	Pumpman
1	Electrician
20	

Third shift

1	Foreman
12	Sinkers
2	Top cagers
2	Hoisting engineers
1	Pumpman
1	Electrician
19	

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